

AD-P003 864

COMBINATION OF THERMAL BURNS AND WHOLE-BODY IRRADIATION

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INTRODUCTION

↙ Despite significant advances in medical technology (such as recognition of physiological derangements, use of topical bactericidal agents, and improved surgical techniques), the care of the thermally burned patient remains a constant challenge to the medical profession. Review of the mortality and morbidity from burn centers across the United States indicates that mortality is usually associated with failures of resuscitation, a significant inhalation injury accompanied by pulmonary insufficiency, or one of the different manifestations of sepsis in the burn patient.

Systemic sepsis in the burn patient that is not due to nosocomial infections or pulmonary injury is usually associated with a colonized or infected burn wound. Burn wound sepsis in some degree is present in most burn wounds beyond the 5th day regardless of topical therapy. However, burn wound sepsis manifests itself only if the bacterial count exceeds 10^5 organisms per gram of tissue. ↗ 100,000

Radiation injuries as a result of industry, accidents, or warfare have occurred during the past 40 years. The combination of thermal burns and whole-body irradiation (WBI) is a real concern in the event of war, terrorist attack, military accidents or a number of industrial mishaps related to the nuclear industry. The synergistic effects of burns and WBI have been demonstrated by several investigators. Standard burn models in animals with a mortality of 20%, when combined with sublethal doses of radiation, result in significant mortality usually associated with sepsis.

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CONTROL OF BURN WOUND SEPSIS

Control of burn wound sepsis has traditionally been attempted by the use of topical bacteristatic agents developed in the past 30 years. Despite the increased use of such agents, control of burn wound sepsis has not been uniformly successful. Furthermore, these topical agents, some of which are toxic in nature, have not totally sterilized the burn wound.

Management of the burn wound can be either aggressive or conservative. Conservative management of the burn wound requires a period of 3 to 4 weeks before deep partial-thickness burns are healed or the eschar of deeper wounds has matured sufficiently so that separation occurs and a viable recipient surface for an autograph is available. The physiologic and metabolic consequences of this period of time between burn and wound closure have been well described, and are characterized by a constant catabolic state requiring significant metabolic support to prevent sepsis or multi-system failure.

Since 1974 the concept of early excision of the burn wound has regained scientific and medical acceptance as described by Burke and his associates.¹ During the past 8 years, a number of centers throughout the United States have adopted the early excision programs for the care of the burn patient. Simultaneously, other major burn centers have indicated that this type of aggressive management does not significantly alter the course of similar burned patients treated in a more conventional fashion. The indications at the present time, in those centers supporting the concept of primary excision of the burn wound, are full-thickness burns or deep partial-thickness burns that require more than 3 weeks to heal. The procedure requires immediate autologous skin grafting and the availability of skin from the patient or other materials to close the wound. Consequently, the availability of skin to close the wound determines the magnitude of the excision. The operative procedures require specialized equipment, specialized anesthetic, knowledge of unique surgical techniques, and significant operating room time. The results of such techniques have been analyzed by the retrospective review of patients as well as by experimental models. Hunt, Baxter, and others reviewed their

experience in split-thickness skin grafting of deep burns of the upper extremity, and concluded that this procedure accomplishes the preservation of tissue, prevention of wound infection, maintenance of function, and early wound closure.²

Heimbach and his associates reviewed their experience on early surgical excisions of the burn wound by comparing burn patients who sustained comparable injuries, they concluded that early excision of the burn wound significantly decreased burn wound colonization, burn wound sepsis, the number of days the patients remained on Chloramphenical, and length of time in hospital. However, they concluded that the patients who underwent early excision required significantly larger volumes of transfused blood.⁴ The immune and metabolic response in the standardized burned guinea pig was addressed by Burke and his associates.⁵ The results established that animals whose burn wounds were excised and then closed sustained much less weight loss, compared to those who were burned and the wound remained untouched. The animals that underwent excisions were free of sepsis. Those that were burned and cared for with topical silvadene developed wound sepsis at day 8. Those that were burned and received no treatment developed wound sepsis at day 5. The immune response of these animals was evaluated by comparing of the weight of the thymus and the relative thymus activity by establishing DNA synthesis. Thymus weights were significantly different in the burned, excised, closed animal when compared with the other models. Simultaneously DNA synthesis was significantly increased in those animals that underwent excision from the 8th through 12th day after burn.

The available literature on burns indicates that the rationale of primary excision of the burn wound is challenged by several investigators. The belief of these investigators is that deep partial-thickness burn wounds will heal adequately without functional defects if treated with appropriate topical antibacterial therapy. With proper topical care, full-thickness burns can be allowed to mature and then be grafted when necessary, without changes in mortality or morbidity.

It is not the point of this presentation to challenge or argue the care of the non-irradiated burn victims. If one accepts the concept that sublethal radiation exposure when associated with a sublethal burn has an increased mortality in animal systems, then early excision of potentially septic tissue and closure of the wound should improve the outcome. The logistics and validity of such a program for treatment of combined injuries, the distribution of resources, and the feasibility of practicing this type of clinical activity in the presence of multiple casualties requires further research, development, and establishment of appropriate policies.

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DISCUSSION PERIOD WITH DR. BURKE

Editors' note: Dr. Burke presented material concerning the problem of burn wound sepsis, but was unable to provide a manuscript for this publication. Therefore, Dr. Hirsch prepared the preceding summary of this topic.

DR. CAMP: Dr. Burke, have you scaled your dermal equivalent up to industrial production yet so that it can be mass-produced?

DR. BURKE: The Marion Laboratories have scaled it up to industrial production, but have been prevented from dispensing it by the FDA. I hope that within the very near future we can begin to send it out to organized centers so we can get experience in addition to ours in Boston.

DR. CAMP: Do you know anyone who is working on maggot enzyme systems?

DR. BURKE: No I don't, nor had I thought of maggot enzyme systems before our friend from Holland showed us.

DR. MESSERSCHMIDT: I know from our experiments with irradiated animals that the open wound is very dangerous. If you close the wound, our animals will survive. I know that war wounds cannot be closed. Therefore, we are always looking at any method to close wounds in an irradiated individual.

DR. BURKE: I think we have all learned from experience, in military disasters and otherwise, that you get into sepsis troubles by closing wounds that ought not to be closed. The important point here is that when a surgeon talks about closing a wound, he is talking about closing it in a definitive way, both anatomically and physiologically. Perhaps that is more complicated than is needed to do immediately after an injury, because we do not have to solve the anatomic problem immediately in the wound closure area, except possibly in the aortic area. In skin wounds we do not have to solve the anatomical problem immediately. However, you do have to solve the physiologic

problems. If you do not solve the physiologic problems, then we are off to the septic races. I want to be sure that you understand that there are a lot of approaches, with artificial skin being one.

DR. HIRSCH: This will not work unless all of the necrotic skin is excised. Yes, it is true that war wounds or high-velocity wounds cannot be closed. However, in addition to learning how to cover the wound, we are going to have to better learn how much one has to excise. Unless the excision of the devitalized tissue is complete, neither that coverage nor any other coverage is going to work.

We may need to change our terminology, redefine our definitions, and reach within the first 24-48 hours a viable physiological surface to which some type of wound closure can be applied. That surface might be artificial skin or autologous graft. But we must not go back to the traditional wound closure, which some people think is just putting two edges of skin together.

DR. BAINES: With the exception of a full-thickness burn, what is your posture toward treatment of the site of injury until you get to some type of expert help? In particular, I refer to antibiotics, a temporary cover, and keeping the wound moist versus dry.

DR. BURKE: Some kind of physiologic cover has to be put on. And unless you can get rid of all of the dead tissue, as Dr. Hirsch has said, you have got to do something to prevent the bacterial growth in that area. Although I have no experience with antibiotics and artificial skin, for instance, I think that may be one approach. There are plenty of bacteria in the world, however, and there is no antibiotic that I know of that will kill them all off. It may be better than nothing, but it is not going to be a definitive solution. Regarding wound closure, we must re-establish normal physiology rather than anatomic integrity immediately. You have to do something to mechanically close the wound plus make any necessary biologic additions.